Fertilizer Guide for Commercial Vegetable Growers

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN • COLLEGE OF AGRICULTURE • COOPERATIVE EXTENSION SERVICE
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COMMERCIAL VEGETABLE PRODUCERS must depend on chemical fertilizers and organic materials along with crop rotation to supply the nutrients essential to their vegetable crops. Although many Illinois soils are highly fertile naturally, they cannot support continuous intensive cropping of vegetables without additional fertilizer. Nutrients can also be replenished by alternating vegetables with green manure or cover crops and by adding manure or other organic materials. Regardless of how the nutrients are added, efficient commercial production of vegetables requires soil testing on a regular basis. Using fertilizer materials efficiently provides greater profits and minimizes the release of potential pollutants into the environment.

Testing Your Soil

To determine how much of each nutrient must be added for optimum crop production, collect soil samples every 2 or 3 years and have them analyzed for pH and for phosphorus and potassium concentrations. The test results and your knowledge of the field's cropping and fertilization history will provide the information you need to develop a fertilization plan for the crop to be grown.

Samples should be collected in the late fall when the soil is relatively dry but not yet frozen. Separate samples should be tested for every field that differs in color, slope, drainage, or previous fertilization and cropping. Each sample should represent no more than 4 acres and should consist of several subsamples collected at random locations throughout the field. Check with your soil testing laboratory for more specific instructions.

Determining Fertilizer Application Rates

The soil test results will be reported in terms of the amount of elemental phosphorus (P) and elemental potassium (K) per acre. Referring to Table 1, determine which of the four soil fertility groups (A through D) your soil's phosphorus test level fits into. Then do the same for the potassium test level. These groups can then be used in conjunction with Table 2 to determine how much of the two nutrients you should add for the crop you plan to grow.

Table 1. Soil Fertility Groups for Phosphorus and Potassium

Fertility group	Nutrient, pounds per acre	
	Bray P_1 phosphorus	Potassium
A	0-25	0-100
B	26-50	101-250
C	51-75	251-350
D	Above 75	Above 350

Locate the crop in Table 2, and then find the column under the phosphorus heading that corresponds to your soil's fertility group for phosphorus. The numbers in the column below the fertility group will tell you how many pounds of P_2O_5 you need to apply per acre to increase the phosphorus content to a satisfactory level. Follow the same procedure using the numbers in the potassium column to determine how much K_2O you should apply. If soil test results are not available, use the amounts of phosphorus and potassium recommended for fertility group B.

Since soil tests for nitrogen are of little value, the nitrogen recommendations in Table 2 are based on the needs of the various crops, but in developing a fertilization program you should also take into account the field's cropping history and the type of soil.

If the crop grown in the field during the previous year was a legume (soybeans or alfalfa), the amount of nitrogen applied can be 25 to 30 pounds per acre less than that recommended in Table 2. The nitrogen status of most vegetable crops can be determined by the color of the foliage. A pale green or slightly yellow color may indicate a need to apply additional nitrogen.

Unless otherwise indicated, the fertilizer recommendations given in this circular are for the mineral soils that predominate in Illinois. Vegetable crops grown on sandy soils usually require greater amounts of nitrogen and potassium. Splitting the nitrogen fertilizer between two separate applications will result in greater efficiency and production on sandy soils that are irrigated or that receive heavy rainfall.

Plantings made early in the season in cool, wet soils may respond well to the application of band-placed phosphorus or a starter solution in addition to the nutrients recommended in Table 2.

Adjusting for Additional Organic Matter

Do not adjust for cover crops because they supply little additional nutrition. Cover crops primarily affect the structure rather than the fertility of the soil. When wheat or rye is plowed down, however, apply a chemical fertilizer to encourage rapid decomposition because decaying wheat and rye may remove 20 to 30 pounds of nitrogen per acre. About 30 percent of this nitrogen will be released to the crop later in the season. If the previous crop was a green manure or a cropped legume, like soybeans or alfalfa, the recommendation for adding nitrogen may be reduced by 25 to 30 pounds per acre. The adjustment for manure is provided in Tables 3 and 4.

Table 2. Fertilizer Recommendations for Vegetable Crops

Crop	Nitrogen (N)	Phosphorus (P_2O_5) Fertility group A	B	C	D	Potassium (K_2O) Fertility group A	B	C	D	Suggested application method
		Recommended application rate based on soil tests								
ASPARAGUS		*pounds per acre*								
New plantings	50	150	50	25	0	150	50	25	0	Broadcast and plow down
	0	50	50	25	25	0	0	0	0	Apply in trench before setting
	30	0	0	0	0	50	50	25	25	Side-dress at first cultivation
Total	80	200	100	50	25	200	100	50	25	
Cutting beds										
Nonhybrids	50	150	100	50	25	200	150	100	50	Broadcast and disk
Hybrids	75	200	150	100	50	300	225	150	75	Broadcast and disk
In sandy soils an additional 50 pounds of nitrogen per acre can be applied as a sidedress after cutting. In new beds build up organic matter with cover crops and manure 1 or 2 years before planting crowns.										
BEANS										
Lima	20	150	100	50	0	150	100	50	0	Broadcast and plow down
	40	40	40	20	20	40	40	20	20	Band 2 in. × 2 in. at seeding
Total	60	190	140	70	20	190	140	70	20	
Snap	0	150	100	50	0	100	50	25	0	Broadcast and plow down
	40	40	40	20	20	40	40	20	20	Band 2 in. × 2 in. at seeding
Total	40	190	140	70	20	140	90	45	20	
Snap, second crop	30	20	20	20	20	40	40	20	20	Band 2 in. × 2 in. at seeding
In sandy soils an additional 25 pounds of nitrogen per acre can be applied as a sidedress when two or three true leaves have appeared. If the soil pH is greater than 6.8, apply 2 pounds of zinc and 1 pound of manganese per acre at planting.										
BEETS	75	150	100	50	25	200	150	100	50	Broadcast and disk
	50	0	0	0	0	0	0	0	0	Side-dress 4 to 6 weeks after planting
Total	125	150	100	50	25	200	150	100	50	
Apply 3 pounds of boron per acre on clay loams and 1 pound per acre on sandy soils.										
BROCCOLI AND	100	200	150	75	50	200	150	75	50	Broadcast and disk
CAULIFLOWER	50	0	0	0	0	0	0	0	0	Side-dress 2 to 3 weeks after transplanting
	25	0	0	0	0	0	0	0	0	Side-dress 5 to 6 weeks after transplanting if required
Total	175	200	150	75	50	200	150	75	50	
If the pH of the soil is greater than 6.5, apply 2 pounds of boron per acre on clay loams and 1 pound per acre on sandy soils. Also, a foliar application of 8 ounces per acre in 100 gallons of water of sodium or ammonium molybdate may avoid molybdenum deficiency. Early plantings in cold soil may respond to a high-phosphorus starter solution.										
CABBAGE, COLLARDS,	75	150	100	50	25	150	100	50	25	Broadcast and disk
AND KALE	50	0	0	0	0	0	0	0	0	Side-dress 4 weeks after planting
Total	125	150	100	50	25	150	100	50	25	
Early plantings in cold soil may respond well to a high-phosphorus starter solution.										
CARROTS	50	150	100	50	25	200	150	100	50	Broadcast and disk
	30	0	0	0	0	0	0	0	0	Side-dress 4 weeks after seeding
Total	80	150	100	50	25	200	150	100	50	
In sandy soils an additional 30 pounds of nitrogen per acre may be applied as a sidedress between 7 and 8 weeks after seeding.										
CELERY	100	250	200	150	100	300	200	100	50	Broadcast and disk
	25	0	0	0	0	0	0	0	0	Side-dress 4 weeks after planting
	25	0	0	0	0	0	0	0	0	Side-dress 8 weeks after planting
Total	150	250	200	150	100	300	200	100	50	
Because celery has a high moisture requirement, irrigation is essential for commercial production. Use of a starter solution is recommended when transplanting celery.										

Table 2. Fertilizer Recommendations for Vegetable Crops (continued)

Crop	Recommended application rate based on soil tests									Suggested application method
	Nitrogen (N)	Phosphorus (P_2O_5) Fertility group				Potassium (K_2O) Fertility group				
		A	B	C	D	A	B	C	D	
	pounds per acre									
CUCUMBERS	50	100	50	0	0	150	100	50	0	Broadcast and plow down
	25	50	50	50	25	50	50	50	50	Band 2 in. × 2 in. at seeding
	25	0	0	0	0	0	0	0	0	Side-dress when vines start to run
Total	100	150	100	50	25	200	150	100	50	
EGGPLANT	75	200	150	100	50	250	150	100	50	Broadcast and disk
	25	0	0	0	0	0	0	0	0	Side-dress 4 weeks after planting
	25	0	0	0	0	0	0	0	0	Side-dress 8 weeks after planting
Total	125	200	150	100	50	250	150	100	50	
Use of a starter solution is recommended when transplanting eggplant.										
HORSERADISH	150	250	200	100	50	250	200	100	50	Broadcast and disk
LETTUCE (LEAF), ENDIVE, AND ESCAROLE	80	200	100	50	25	200	100	50	25	Broadcast and disk
	40	0	0	0	0	0	0	0	0	Side-dress 3 to 5 weeks after planting
Total	120	200	100	50	25	200	100	50	25	
Apply only 75 pounds of nitrogen per acre to head lettuce because excessive nitrogen may result in loose heads.										
MUSKMELON	50	150	100	50	0	150	100	50	0	Broadcast and plow down
	25	50	50	50	50	50	50	50	50	Band 2 in. × 2 in. at seeding
	25	0	0	0	0	0	0	0	0	Side-dress when vines start to run
Total	100	200	150	100	50	200	150	100	50	
On sandy soils increase the nitrogen sidedressing to 50 pounds of nitrogen per acre when vines start to run.										
ONIONS	75	200	100	50	25	200	100	50	25	Broadcast and disk
	25	0	0	0	0	0	0	0	0	Side-dress 4 to 5 weeks after planting
Total	100	200	100	50	25	200	100	50	25	
For green onions an additional 25 pounds of nitrogen per acre can be applied as a sidedress from 4 to 5 weeks before harvest.										
PARSLEY	75	200	150	100	50	200	150	100	50	Broadcast and disk
	25	0	0	0	0	0	0	0	0	Side-dress at each cutting
Total	100	200	150	100	50	200	150	100	50	
PEAS	0	100	50	25	0	100	75	50	25	Broadcast and disk
	50	50	50	50	50	50	25	25	25	Band 2 in. × 2 in. at seeding
Total	50	150	100	75	50	150	100	75	50	
After periods of heavy rains in the spring an additional 30 pounds of nitrogen per acre can be applied when peas are 4 to 6 inches tall. Apply only when the plants are dry to avoid burning the foliage.										
PEPPERS	100	200	150	100	50	250	150	100	50	Broadcast and disk
	50	0	0	0	0	0	0	0	0	Side-dress after first fruit set
Total	150	200	150	100	50	250	150	100	50	
In sandy soils an additional 25 pounds of nitrogen may be applied as a sidedress after the first harvest. The use of a starter solution is recommended when transplanting peppers.										
POTATOES	0	150	100	0	0	200	150	100	50	Broadcast and disk
	100	100	100	100	100	100	100	100	50	Band-place at planting
	50	0	0	0	0	0	0	0	0	Side-dress at emergence
Total	150	250	200	100	100	300	250	200	100	
In sandy soils an additional 30 pounds of nitrogen can be applied as a sidedress before the plants are about 8 or 10 inches tall. On soils with magnesium test values less than 250 pounds per acre, apply 50 pounds magnesium (MgO) per acre at planting.										
PUMPKINS	90	150	100	50	25	200	150	100	50	Broadcast and disk
	30	0	0	0	0	50	0	0	0	Side-dress when vines start to run
Total	120	150	100	50	25	250	150	100	50	
Excessive use of nitrogen may result in thin walls and a flat side on jack-o'-lanterns.										

Table 2. Fertilizer Recommendations for Vegetable Crops (continued)

Crop	Nitrogen (N)	Phosphorus (P_2O_5) Fertility group A	B	C	D	Potassium (K_2O) Fertility group A	B	C	D	Suggested application method
		pounds per acre								
RHUBARB										
New plantings	50	250	200	150	100	250	200	150	50	Broadcast and plow down
	50	0	0	0	0	0	0	0	0	Side-dress around each hill 2 weeks after growth starts
Total	100	250	200	150	100	250	200	150	50	
Cutting beds	50	200	150	100	50	250	150	100	50	Side-dress each hill in early spring
	50	50	50	50	50	50	50	50	50	Side-dress at last harvest
Total	100	250	200	150	100	300	200	150	100	
SPINACH	100	200	150	100	50	200	150	100	50	Broadcast and disk
	20	0	0	0	0	0	0	0	0	Side-dress 4 to 5 weeks after planting
Total	120	200	150	100	50	200	150	100	50	
SQUASH	75	150	100	50	25	200	100	50	25	Broadcast and disk
	25	0	0	0	0	0	0	0	0	Side-dress when vines start to run
Total	100	150	100	50	25	200	100	50	25	
SWEET CORN	100	150	100	75	50	200	100	75	50	Broadcast and disk
	30	0	0	0	0	0	0	0	0	Side-dress when corn is 12 in. tall
Total	130	150	100	75	50	200	100	75	50	
On soils low in phosphorus or for early plantings band (2 inches × 2 inches) 30 pounds of phosphorus per acre at seeding.										
SWEET POTATO	60	200	150	100	50	200	150	50	0	Broadcast and plow down
TOMATOES — Fresh Market										
On sandy soils	100	250	200	100	50	200	150	75	50	Broadcast and plow down
	25	0	0	0	0	50	50	25	0	Side-dress at first cultivation
	25	0	0	0	0	50	0	0	0	Side-dress after first fruit set
Total	150	250	200	100	50	300	200	100	50	
The second sidedress may not be required on early or semideterminate tomatoes.										
On loams	100	250	200	100	50	250	150	100	50	Broadcast and plow down
	25	0	0	0	0	0	0	0	0	Side-dress at first cultivation
Total	125	250	200	100	50	250	150	100	50	
— Processing: Transplants/Direct seeded										
On sandy soils	60/50	250	200	100	50	200	150	50	0	Broadcast and disk
	30/25	0	0	0	0	50	50	50	50	Side-dress transplants 4 weeks after planting and direct seeded tomatoes 6 weeks after planting
	0/0	0	0	0	0	50	0	0	0	
Total	90/75	250	200	100	50	300	200	100	50	
On loams	50/30	250	200	100	50	200	100	50	50	Broadcast and disk
	25/30	0	0	0	0	50	50	50	0	Side-dress transplants 4 weeks after planting and direct seeded tomatoes 6 weeks after planting
Total	75/60	250	200	100	50	250	150	100	50	
The use of a starter solution is recommended when transplanting tomatoes.										
TURNIPS	50	100	75	50	0	100	50	0	0	Broadcast and disk
Apply 2 pounds of boron per acre on clay loams and 1 pound per acre on sandy soils.										
WATERMELONS	50	150	100	50	0	150	100	50	0	Broadcast and plow down
	25	50	50	50	50	50	50	50	50	Band 2 in. × 2 in. at seeding
	25	0	0	0	0	0	0	0	0	Side-dress when vines start to run
Total	100	200	150	100	50	200	150	100	50	
On sandy soils increase the nitrogen sidedressing to 50 pounds of nitrogen per acre when vines start to run.										

Table 3. Reduction in Fertilizer Application for Applied Liquid Manures[a]

Manure source	Nitrogen: Time of application: Fall or winter	Nitrogen: Time of application: Spring uncovered	Nitrogen: Time of application: Spring covered or injected	Phosphorus	Potassium
			pounds per acre		
Cattle, mixed livestock	5	10	12	4	16
Poultry	23	46	58	22	26
Swine	8	15	19	7	14

[a] Assuming an application of 900 gallons per acre.

Table 4. Reduction in Fertilizer Application for Applied Solid Manure[a]

Manure source	Nitrogen: Time of application: Fall or winter	Nitrogen: Time of application: Spring uncovered	Nitrogen: Time of application: Spring covered or injected	Phosphorus	Potassium
			pounds per acre		
Cattle, mixed livestock	12	24	30	10	44
Poultry	70	140	175	75	96
Swine	15	30	38	20	26

[a] Assuming an application of 4.5 tons per acre.

Other Nutrient Requirements

Calcium and magnesium. Calcium and magnesium are dominant cations in most Illinois soils. Most vegetable crops need relatively small amounts of calcium. A calcium deficiency is extremely rare in soils with a pH value of 5.0 and above and unlikely even in soils that require lime to correct acidity. Soil test levels for calcium of 500 pounds per acre on sandy soils and of 900 pounds per acre on silt loams are adequate for most vegetable crops.

It is more probable that you will encounter a magnesium deficiency while growing vegetables, especially when the soil is acid and sandy or when large amounts of calcitic limestone or marl have been applied to soils already low in magnesium. Excessive potash fertilizer may also cause a magnesium deficiency on some sandy soils. Soil test values for magnesium of 80 pounds per acre on sandy soil and 180 pounds per acre on silt loams are adequate. Apply dolomitic limestone on acid sandy soils that need magnesium. Other suitable magnesium fertilizers include magnesium sulfate (Epsom salts) and potassium-magnesium-sulfate. Foliar application of 20 pounds of magnesium sulfate in 60 gallons of water is a quick remedy for magnesium deficiency in several vegetables. Vegetables that respond to magnesium include cauliflower, muskmelons, peppers, potatoes, and pumpkins.

Sulfur. Vegetable crop soils in Illinois are not usually known to be deficient in sulfur, and field tests have not shown a significant yield response to applications of this nutrient. Environmental sources of sulfur usually satisfy the needs of plants. These sources include mineralized organic matter, atmospheric sulfur (released from emissions of fossil fuels and returned to the soil in precipitation), and fertilizer by-products. With greater control of air pollution and increased use of high analysis fertilizers, the amount of sulfur obtained from fertilizer by-products and emissions of fossil fuels is declining. As a result sulfur deficiencies may develop in the next five to fifteen years and are most likely to occur in sandy soils or in soils low in organic matter located upwind from urban industrial areas.

Soil tests for sulfur are not very reliable because sulfate ions are highly mobile in the soil. Low soil tests for sulfur should be confirmed by tissue analysis. Most vegetable crops require as much sulfur as phosphorus. Either elemental or sulfate forms of sulfur fertilizers can be used on vegetable crops. Sulfate-sulfur reacts more quickly than elemental sulfur in supplying the needs of plants. In general, the practice of applying sulfur involves little risk. Applying too much, that is, enough to reduce yields, would be difficult. It should be noted, however, that applying moderate to high levels of elemental sulfur or using ammonium sulfate leaves an acid residue in the soil. For most crops an application of 10 to 20 pounds of sulfur per acre should correct a sulfur deficiency.

Micronutrients. The elements boron, manganese, iron, molybdenum, copper, zinc, and chlorine are essential for plant growth but needed in very small amounts. Green plants, for example, require about 150,000 times more nitrogen than molybdenum. Deficiencies, therefore, are quite rare and usually occur in fairly predictable situations. Maintenance of soil pH between 6.2 and 6.8 is the best means of avoiding both excesses and deficiencies of micronutrients. For information on when micronutrient deficiencies are likely to occur and how to avoid or correct them, see *Horticulture Facts* VC-17-81, "Micronutrient Applications for Vegetable Crops," available from the Department of Horticulture. Preventative applications on a routine basis are not recommended for most vegetables and soils.

Crop Rotations and Organic Matter

Soil organic matter breaks down very rapidly in soils used for vegetable production because of the intensive cultivation and the frequent irrigation. Including grasses or legumes in a crop rotation at least once every three years helps maintain organic matter as well as the good structure and friability of the soil. Clay or silt loam soils with good structure will have improved drainage, and sands or sandy loams with good organic matter will hold water better.

Seeding a cover crop in the fall is a common practice on sandy soils that are subject to blowing. Loamy soils can also benefit from cover crops since root growth and the organic residues from these crops can improve the structure of the soil as well as reduce erosion. The most commonly used cover crops are oats, wheat, and rye.

1. Oats should be seeded at 60 to 100 pounds per acre during September or October to provide a good cover that will die out over the winter.
2. Winter wheat or rye should be seeded at 80 to 110 pounds per acre in September or October. These should be plowed down in the spring before they become too vegetative.

Green manure crops are grown during the same season as a cash crop for the purpose of improving the tilth of the soil. Most commercial vegetable operations cannot allow land to be nonproductive, but small farmers may use green manures as a source of nitrogen for subsequent crops. Common green manure crops are sweet clover, soybeans, sudan grass, and a mixture of peas and oats.

1. Sweet clover should be seeded at 15 to 25 pounds per acre in the spring. This may add as much as 100 pounds of nitrogen per acre during the next several years.
2. Soybeans should be inoculated and seeded at 120 pounds per acre.
3. Sudan grass may be seeded at 35 pounds per acre.
4. A mixture of peas at 65 pounds per acre and oats at 100 pounds per acre may be sown early in the spring and plowed down later to allow for a fall crop.

Generally, 30 to 40 pounds of nitrogen and all of the phosphorus and potassium required for the next crop should be applied before the cover crop or green manure. Approximately 30 percent of the nitrogen will be recovered by the first vegetable crop.

Animal manure is the most common type of organic matter and should be used whenever available. Manure can supply an appreciable amount of nitrogen and phosphorus. More nitrogen will be available if manure is applied in the spring, especially if it is immediately covered with soil to prevent the loss of ammonia nitrogen. Manure can also be injected to prevent the loss of nitrogen and to reduce the likelihood of the runoff of phosphorus into streams.

When more than one crop is to be grown in a field it is necessary to adjust the fertilizer application rates so that the nutrients needed by all of the crops are supplied. Tailoring a fertilizer program for such situations is difficult because the amount of a nutrient that is considered adequate for one crop may be undesirably low for another. For assistance, consult *Horticulture Facts* No. VC-7-80, "Fertilizer Guide for Market Gardeners." Other publications in this series that may be of interest to you are No. VC-8-80, "Conversion Tables for Fertilizer Calculations," and No. VC-18-81, "Liming Vegetable Crops." You can obtain these publications from your county Cooperative Extension Service adviser or from the Department of Horticulture, 124 Mumford Hall, 1301 West Gregory Drive, University of Illinois, Urbana, Illinois 61801.

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